2. METHODS

The sampling and analytical methods used for SCECAP are fully described in the first SCECAP report covering the 1999-2000 survey period (Van Dolah *et. al.*, 2002a). This report and associated data can also be viewed and downloaded from the SCDNR's SCECAP web site (http://www.dnr.sc.gov/marine/scecap/). Descriptions of the SCECAP sampling design, measured parameters, and general analytical approach are summarized in the following sections. In general, this program utilizes methods consistent with SCDHEC's water quality monitoring programs (SCDHEC, 2001) and the USEPA's NCA Program (http://www.epa.gov/emap/nca/index.html).

2.1. Sampling Design

Approximately 60 stations were selected for sampling each year within South Carolina's coastal zone extending from the Little River Inlet at the South Carolina - North Carolina border to the Savannah River at the South Carolina - Georgia border and extending from the saltwater-freshwater interface to near the mouth of each estuarine drainage basin. Approximately half of the stations were located in tidal creeks, and the other half were located in the larger open water bodies that form South Carolina's tidal rivers, bays, and sounds. Tidal creeks are defined as those estuarine water bodies less than 100 m wide from marsh bank to marsh bank. Portions of the state's coastal waters that are too shallow to sample at low tide, such as the headwater portions of tidal creeks with less than 1 m of water at low tide, intertidal mud flats, and vegetated salt marsh, were excluded from the station selection process. All stations had to have a minimum water depth of 1 m since some sampling components required visits that could not be limited by tidal stage, and other sampling components were limited to periods within three hours of low tide. Coastal maps developed for SCECAP to define the boundaries of tidal creeks and open water habitats suitable for sampling by this program indicate that approximately 17% of the state's estuarine waters by surface area represents creek habitat, and the remaining 83% represents the larger open water areas.

A typical tidal creek habitat in South Carolina.

Stations within each habitat type were selected using a probability-based, random tessellation, stratified sampling design (Stevens, 1997; Stevens and Olsen, 1999), with new station locations assigned each year. Actual sampling locations were recorded using the Global Positioning System (GPS). Each year, a new set of random stations was generated.

All stations were sampled once during the summer (late June through August). The summer period was selected since it represents a period when some water quality variables may be limiting to biota, and it is a period when many of the fish and crustacean species of concern are utilizing the estuary for nursery habitat. Most of the measures were collected within a 2-3 hr time period; however, the water quality data also includes time-series measures collected over a 25-hr time period. Approximately 30 of the sites sampled each year (15 tidal creek and 15 open water) were also sampled monthly by SCDHEC for most water quality measures, except dissolved nutrients and total suspended solids (TSS), to collect a full 12 months of data for each site. The results of that sampling effort are compared to the summer-only integrated index of water quality condition for the state in order to assess the validity of the summer assessment relative to year-round water quality measurements (See Box 3.2.2).

2.2. Water Quality Measurements

Water quality measurements and samples were generally collected prior to deployment of other sampling gear to ensure that bottom disturbance did not affect these measures. Near-surface (0.3 m depth), mid-water, and near-bottom (0.3 m above bottom) instantaneous measurements of dissolved

oxygen, salinity, and temperature were collected using Yellow Springs Instrument (YSI) Inc. Model 85 water quality meters. Near-surface measures of pH were collected using a pHep® 3 field microprocessor meter. More extensive time-profile measurements of all four parameters were obtained from the near-bottom waters of each site using YSI Model 6920 multiprobes logging at 15 min intervals for a minimum of 25 hrs to assess conditions over two full tidal cycles representing both day and night conditions.

Water quality samples included near-surface measures of nitrogen (including ammonia, nitrate/nitrite, total Kjeldahl nitrogen (TKN), and total nitrogen (TN)), total phosphorus (TP), total organic carbon (TOC), total suspended solids (TSS), turbidity, five-day biochemical oxygen demand (BOD_5), chlorophyll-*a*, and fecal coliform bacteria concentrations. Near-surface measures of dissolved nutrients, including ammonia, inorganic nitrogen (DIN), organic nitrogen (DON), inorganic phosphorus (orthophosphate or OP), organic phosphorous (DOP), and silica (DS), were also collected. All samples were collected by inserting pre-cleaned water bottles to a depth of 0.3 m inverting and then filling the bottle directly at that depth. Water samples collected for dissolved nutrient quantification were filtered in the field through a 0.45 µm pore cellulose acetate filter. The bottles were then stored on ice until they were returned to the laboratory for further processing. Total nutrients, TOC, total alkalinity, TSS, turbidity, BOD_5, chlorophyll-*a*, and fecal coliform bacteria samples were processed by SCDHEC using standardized procedures (SCDHEC, 1998b, 2001, 2005). Dissolved nutrients were processed through the University of South Carolina using a Technicon AutoAnalyzer and standardized procedures described by Lewitus *et al.* (2003). DON and DOP were calculated by subtracting total inorganic from total dissolved N or P, measured by the persulfate oxidation technique (D'Elia *et al.,* 1977).

2.3. Biological and Sediment Sampling

Bottom sediment samples were collected at each station using a stainless steel 0.04 m^2 Young grab deployed from an anchored boat. The boat was repositioned between each sample to ensure that the same bottom was not sampled twice and to spread the samples over a 10-20 m^2 bottom area. The grab was thoroughly cleaned prior to field sampling and rinsed with isopropyl alcohol between stations. Three of the grab samples were washed through a 0.5 mm sieve to collect the benthic invertebrate fauna which were then preserved in a 10% buffered formalin-seawater solution containing rose bengal stain. The surficial sediments (upper 3 cm) of the remaining grab samples were homogenized on site and placed in pre-cleaned bottles for analysis of sediment composition, contaminants, and sediment toxicity. All sediment samples were kept on ice while in the field and then stored either at 4°C (toxicity, porewater) or frozen (contaminants, sediment composition, TOC) until analyzed.

The Young "grab" is used to collect sediments and benthic fauna. Photo credit: R. Van Dolah

Particle size analyses were performed using a modification of the pipette method described by Plumb (1981). Pore water ammonia was measured using a Hach Model 700 colorimeter and TOC was measured on a Perkin Elmer Model 2400 CHNS Analyzer.

Contaminants measured in the sediments included 22 metals, 25 polycyclic aromatic hydrocarbons (PAHs), 79 polychlorinated biphenyls (PCBs), 13 polybrominated diphenyl ethers (PBDEs), and 21 pesticides. All contaminants were analyzed by the NOAA-NOS Center for Coastal Environmental Health and Biomolecular Research (CCEHBR) using procedures similar to those described by Krahn *et al.* (1988), Fortner *et al.* (1996), Kucklick *et al.* (1997), and Long *et al.* (1997).